IN THE APPLICATION OF

ERIC D. HYP

FOR AN

ELECTRICALLY OPERATED RATCHETING PAWL LATCH

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CROSS-REFERENCE TO RELATED APPLICATION

This utility patent application is based on U.S. provisional patent application number 60/216,752, filed July 7, 2000.

BACKGROUND OF THE INVENTION

1. Field of the invention.

The present invention is a latch for actuation with both an electric motor and manually.

2. Description of the related art.

Latch assemblies are relied on in many applications for securing items, such as panels, together. For example, containers, cabinets, closets, compartments and the like may be secured with a latch. An important use for latches is in the automotive field, where there is a desire and need to access automotive compartments, such as, for example, the trunk or passenger compartments of vehicles, as well as interior compartments such as a glove box.

Various latches for panel closures have been employed where one of the panels such as a swinging door or the like is to be fastened or secured to a stationary panel or compartment body. The prior art devices generally utilize a locking member which is spring-loaded externally by one or more separately provided torsion springs. For example, some prior art devices rely upon a lock which comprises rigid metal parts and requires additional biasing members for operation of the assembly. It has been increasingly more important and desirable to provide remote features for operation of latch mechanisms which permits a user to operate the latch from a location remote of that at which the latch is installed. For example, automobile latches often rely on the use of remote devices to open and close door locks, for example, using infrared, radio, or other wireless transmission modes. In addition,

vehicle trunks often are provided so that they can be unlocked by remote means to permit the raising or opening of a panel.

In furnishing remote latching mechanisms, it must be taken into account that in some instances remote means may have failures, such as, for example, due to a loss of power supply (especially where electronic circuitry is employed). It is therefore also desirable to provide additional or secondary latching capabilities in order that the latch can be locked or opened manually, should the remote mechanism fail. In some instances, capped openings are provided in the vicinity of the latch which can permit a user to access the latch to open it should the remote mechanism not be operable. However, where security is concerned, it is not practical to provide an easy means for gaining an ability to open a latch. In these instances, complex mechanisms have been employed.

It is desirable to provide a latch which can be utilized both, by a remote locking mechanism and a key operated mechanism, and furthermore, where both the remote and the key operation can be used alternately as desired by the user. That is, it is desirable to have a latch with a locking capability where either a remote locking mechanism or a manual (key type) mechanism can be used to lock or unlock the latch, regardless of which one had previously been used.

The present invention provides a novel ratcheting pawl latch with the ability to lock and unlock the latch with remote and key operated mechanisms.

SUMMARY OF THE INVENTION

The present invention is a latch that may be operated either by an electric motor, possibly remotely, or manually. The latch includes a lockplug housing, a motor housing, a lockplug, a lockplug driver, a locking disk, a pawl, and a pair of roller switches.

The pawl includes a pair of arms and a locking disk engagement tooth. The pawl pivots between a latched and unlatched position, and is spring-biased towards its unlatched position. The pawl is dimensioned and configured to secure a wire keeper between its two arms.

The locking disk is pivotally secured between the lockplug housing and the motor housing. The locking disk defines a bearing surface around its circumference, which further defines a window dimensioned and configured to permit passage of the pawl, and a pair of cutouts. The locking disk pivots between a locked position and an open position, defining an unlocked range of positions therebetween. The locking disk is spring-biased away from the open position, but is not spring-biased in either the locked position or the unlocked range of positions. In the locked and unlocked positions, the edge of the locking disk abuts the locking disk engagement tooth of the pawl, thereby securing the pawl in its latched position. When the locking disk is rotated to the unlocked position, the window is aligned with the pawl, allowing the pawl to rotate to its unlatched position. The locking disk will then abut the pawl's locking disk engagement tooth, preventing the locking disk from rotating out of the locked position.

One side of the locking disk engages a gearbox, which in turn engages a motor. The motor is preferably a 12-volt DC motor, but is not limited to this type. The DC motor may be controlled by any of several means, including a programmable logic controller, a dashboard mounted switch, and/or a remote switch. The opposite side of the locking disk engages the lockplug driver.

The lockplug and lockplug driver turn as a single unit within the lockplug housing. The lockplug is spring-biased towards a central position. The lockplug driver engages the locking disk by means of a pin projecting from the locking disk into a slot in the lockplug driver. The slot extends for 90° around the lockplug driver. Therefore, the lockplug must be rotated 45° in either direction before engaging the locking disk. Likewise, when the motor rotates the locking disk, the locking disk is free to rotate 45° before engaging the lockplug driver. This is necessary because a force applied to rotate the lockplug will rotate the DC motor as well, but a force applied through the DC motor will have no way to rotate the lockplug.

The latch includes a pair of roller switches between the motor housing and lockplug housing. Each roller switch includes a cantilever with a roller end abutting the bearing

surface of the locking disk. Depressing the cantilever closes an electrical circuit. When the roller abuts a cutout in the locking disk, the cantilever is extended, opening the circuit. Likewise, when the roller abuts the other portions of the disk's bearing surface, the cantilever is depressed. One cutout corresponds to the latch's locked position, and the other corresponds to the latch's open position. Therefore, the first of the two roller switches will be open when the latch is locked, and the second of the two roller switches will be open when the latch is open. The combined state of the two latches therefore indicates whether the latch is locked, unlocked, or open. This signal can be directed to a programmable logic controller (PLC), which, given the current state of the latch, and the desired state of the latch from a remote controller, will turn the motor the proper amount to bring the latch into the desired state. For example, if the latch is unlocked (both roller switches closed) and the user switches the latch to open, the PLC will rotate the motor until the second roller switch engages the corresponding cutout in the locking disk and opens. The PLC will then receive a signal that the latch is open, and stop rotating the motor.

It is a principal object of the present invention to provide a novel latch assembly which is selectively engagable with a keeper member, and includes a spring locking member which is spring-loaded with its own spring force for engaging and releasing a pawl from a keeper member when a handle is actuated.

It is another object of the present invention to provide a locking member which is comprised of spring steel or plastic.

It is another object of the present invention to provide a latch assembly with a locking component which can be operated with a key or other operator, such as radio, infrared, electronic or other means, which selectively engages the locking member against movement.

It is another object of the present invention to provide a latch assembly with a locking mechanism which can be operated with a key or other operator, such as, a solenoid controller, where the key and solenoid control the same locking element but provide independent ways to lock and unlock the latch.

These and other objects of the invention will become apparent through the following description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an electrically operated ratcheting pawl latch according to the present invention.

FIG. 2 is a rear view of an electrically operated ratcheting pawl latch according to the present invention.

FIG. 3 is a side view of an electrically operated ratcheting pawl latch according to the present invention.

FIG. 4 is an exploded perspective view of an electrically operated ratcheting pawl latch according to the present invention.

FIG. 5 is an exploded side view of an electrically operated ratcheting pawl latch according to the present invention.

FIG. 6 is a perspective view of a lockplug housing for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 7 is a bottom view of a lockplug housing for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 8 is a rear view of a lockplug housing for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 9 is a perspective view of a motor housing for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 10 is a side view of a motor housing for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 11 is a rear view of a motor housing for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 12 is a perspective view of a lockplug for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 13 is a front view of a lockplug for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 14 is a side view of a lockplug for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 15 is a perspective view of a lockplug driver for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 16 is a front view of a lockplug driver for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 17 is a rear view of a lockplug driver for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 18 is a perspective view of a locking disk for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 19 is a side view of a locking disk for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 20 is a rear view of a locking disk for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 21 is a perspective view of a pawl for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 22 is a perspective view of a pawl spring for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 23 is a perspective view of a roller switch for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 24 is a perspective view of a sungear for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 25 is a perspective view of a torsion spring for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 26 is a perspective view of a gearbox for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 27 is a perspective view of a motor for an electrically operated ratcheting pawl latch according to the present invention.

FIG. 28 is a perspective view of an electrically operated ratcheting pawl latch according to the present invention, showing the latch locked.

FIG. 29 is a perspective view of an electrically operated ratcheting pawl latch according to the present invention, showing the latch unlocked.

FIG. 30 is a perspective view of an electrically operated ratcheting pawl latch according to the present invention, showing the latch open.

Like reference numbers denote like elements throughout the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is an electrically operated ratcheting pawl latch. Referring to **FIGS. 1-5**, the latch **10** includes a lockplug housing **50**, a motor housing **100**, a lockplug **150**, a lockplug driver **200**, a locking disk **250**, a pawl **300**, a pair of roller switches **350**, at least one gearbox **400**, and a motor **450**.

Referring to **FIGS. 6-8**, the lockplug housing **50** is illustrated. The lockplug housing **50** includes a front **52**, a bottom **54**, a pair of sides **56, 57**, and a top **58**. The front **52** defines a channel **60** dimensioned and configured to receive a lockplug driver **200** (described below) and a cylinder **62** dimensioned and configured to receive a lockplug **150**. The cylinder **62** defines a recess **64** for receiving a plurality of locking wafers of the lockplug **150** (described below). A pawl nest **66** protrudes from the bottom **54**, and a window **68**, dimensioned and configured to receive a pawl **300** (described below), is defined in that portion of the bottom **54** within the pawl nest **66**. The pawl nest **66** preferably includes a pair of coaxial apertures **67**. Referring specifically to **FIG. 8**, illustrating the rear or inside portion of the lockplug housing **50**, a locking disk wall **70** is illustrated surrounding the channel **60**. A lockplug torsion spring driving tooth **72** is defined within the channel **60**, adjacent to the cylinder **62**. A locking disk torsion spring tooth **74** is defined opposite the tooth **72**, adjacent to the cylinder **62** but outside the channel **60**. Adjacent to one side **56**, a plurality of risers **76**

is positioned for retaining a pair of roller switches **350** (described below). The side **56** defines a pair of windows **78** for permitting access to the contacts on the roller switches **350**, best seen in **FIG. 7**. The lockplug housing **50** preferably includes a plurality of mounting holes **80** for securing the lockplug housing **50** to the motor housing **100**.

The motor housing **100** is best illustrated in **FIGS. 9-11**. The motor housing **100** includes a panel **102**, from which a rearward portion **104** extends. The rearward portion **104** defines a motor-containing portion **106** and a gearbox-containing portion **108**. The motor-containing portion **106** preferably includes a window **110** for passage of the electrical contacts to the motor **450**. The opposite side of the panel **102** includes a perimeter wall **112**, dimensioned and configured to contain the locking disk **250**. The motor housing **100** includes risers **114**, dimensioned and configured to secure the roller switches **350** in place. A guide slot **118** is defined around a 90° section of the perimeter wall **112**. The panel **102** preferably includes mounting holes **116** for securing the motor housing **100** to the lockplug housing **50**.

A lockplug **150** is illustrated in **FIGS. 12-14**. The lockplug **150** includes a key slot **152** within its front end **154**. The rear of lockplug **150** may include a peg **156**. A plurality of wafers **158** extends from slots **160** within the side wall **162** of lockplug **150**. When a key is inserted and engages tumblers **164**, the wafers **158** are retracted. Likewise, removing the key extends the wafers **158**. A retention wafer **166** is spring-biased outward from a slot **168** within the side wall **162**.

A lockplug driver **200** is illustrated in **FIGS. 15-17**. The lockplug driver **200** includes a cylinder **202**, dimensioned and configured to receive the lockplug **150**. The cylinder **202** includes a slot **204**, dimensioned and configured to receive the retention wafer **166**. The rear portion **206** includes an aperture **208**, dimensioned and configured to receive the lockplug's peg **156**. Opposite the cylinder **202**, the rear portion **206** also defines a central aperture **212**, and a channel **214**, extending for 90° around the aperture **212**. The aperture **212** is dimensioned and configured to engage a center post of the locking disk **250** (described below). The channel **214** is dimensioned and configured to engage a driver post

on the locking disk **250**. A spring retaining tab **210** protrudes outward to one side of the cylinder **202**.

The lockplug **150** is inserted into the lockplug driver **200** so that the retention wafer **166** engages the slot **204**, and the peg **156** engages the aperture **208**. In use, the lockplug **150** and lockplug driver **200** will rotate as a single unit, and will be biased towards the position wherein the wafers **158** will engage the recess **64**. The means for biasing the lockplug **150** and lockplug driver **200** is preferably a spring such as the spring **550** illustrated in **FIG. 25**.

The locking disk **250** is best illustrated in **FIGS. 18-20**. The locking disk **250** includes a central post **252** and a driver post **254** on its front face **256**. The front face **256** also defines a cavity **258**, dimensioned and configured to receive a spring and the locking disk torsion spring tooth **74** of the lockplug housing **50**. A spring retention feature **272** is also defined within the cavity **258**. The rear face **260** includes an aperture **262**, dimensioned and configured to receive a sungear **500** (illustrated without teeth in **FIG. 24**), and a deadstop lug **264**, dimensioned and configured to engage the slot **118** within the motor housing **100**. The locking disk's circumference **266** defines a bearing surface having a pair of cutouts **268**, and a window **270**, dimensioned and configured to receive the pawl **300**.

The locking disk **250** is positioned immediately behind the lockplug driver **200**, with the central post **252** engaging the aperture **212**, and the driver post **254** engaging the slot **214**. In use, the locking disk **250** will pivot between an open position and a locked position, with an unlocked range of positions defined therebetween, and will be biased away from the open position. Preferred and suggested means for biasing the locking disk **250** away from the open position is the spring **550**.

The pawl **300** is illustrated in **FIG. 21**. The pawl **300** includes a locking disk engaging tooth **302**, a first arm **304**, and a second arm **306**. The arms **304, 306** are substantially parallel and opposite the locking disk engaging tooth **302**. A slot **310** is defined between arms **304, 306**, and is dimensioned and configured to receive a wire keeper (not shown, and well-known). The pawl **300** also includes means for pivotally securing it within the latch **10**,

with preferred and suggested means being pegs **308**, dimensioned and configured to mate within the apertures **67** within the pawl nest **66**. With the pawl **300** secured within the apertures **67**, the pawl **300** will pivot between a latched position and an unlatched position, and will be biased towards its unlatched position. Preferred and suggested means for biasing the pawl **300** towards its unlatched position are the spring **552**, illustrated in **FIG. 22**. The locking disk **250** will abut locking disk engaging tooth **302** of the pawl **300** when the locking disk **250** is in the locked or unlocked positions. In the open position of the locking disk **250**, the pawl **300** will be aligned with the window **270**.

Located rearward of the locking disk **250** is at least one gearbox **400**, illustrated in **FIG. 26**, and a motor **450**, illustrated in **FIG. 27**. The gearbox **400** is preferably a planetary gearbox. The motor **450** is preferably a 12 volt DC motor. The motor **450** is located within the motor containing portion **106** of the motor housing **100**, and is powered through electrical contacts passing through the window **110**. The motor **450** is connected through a sungear **500** to the gearbox **400**, located within the gearbox containing portion **108** of the motor housing **100**. The gearbox **400** is connected to the locking disk **250** by a second sungear **500**, fitting within the aperture **262**.

Referring to **FIG. 23**, a roller switch **350** is illustrated. Roller switch **350** includes a cantilever **352**, terminating in a roller **354**. A contact **356** is located beneath the cantilever **352**, so that depressing cantilever **352** closes an electrical circuit, and releasing cantilever **352** opens the circuit. Electrical contacts **358** allow connection of the roller switch **350** to an electrical circuit. Each of the two roller switches **350** is located adjacent to the locking disk **250**, so that the roller **354** abuts the locking disk's bearing surface **266**. The contacts **358** are adjacent to the windows **78**. Cantilever **352** is depressed unless the roller **354** has engaged one of the cutouts **268**. Therefore, the cantilever **352** of the roller switch **350a** is released when the locking disk **250** is in the locked position, and the cantilever **352** of the roller switch **350b** is released when the locking disk **250** is in the open position. Both cantilevers **352** are depressed when the locking disk **250** is in the unlocked position.

Therefore, a distinct signal is generated designating the locking disk's locked, unlocked, and open positions.

Operation of the latch **10** is best illustrated in **FIGS. 28-30**. The latch **10** may be operated either manually or by the motor **450**. In the locked position, illustrated in **FIG. 28**, the locking disk **250** is rotated so that the window **270** is 90° to the pawl **300**, the roller switch **350** engages one cutout **268** so that it is open, and the deadstop lug **264** is at one end of the slot **118**. The keeper is secured between the pawl's arm **304** and the pawl nest **66**. The pawl's locking disk engaging tooth **302** abuts the locking disk **250**, thereby securing the pawl **300** in the latched position.

To operate the latch **10** manually, a key is first inserted into the key slot **152** of the lockplug **150**. The wafers **158** retract as the key is inserted, allowing the lockplug **150** to rotate. The key is rotated clockwise. The lockplug driver **200** will engage the driver post **254**, rotating the locking disk **250**. If merely unlocking the latch **10** is desired, the rotation may stop anywhere in the unlocked range, such as illustrated in **FIG. 29**. As the locking disk **250** is rotated from the locked to the unlocked positions, the cantilever **352** of roller switch **350a** is depressed, so that both roller switches **350** are closed. The pawl **300** remains secured in the latched position.

Once the locking disk **250** is rotated to the unlocked position illustrated in **FIG. 30**, the window **270** is adjacent to pawl **300**, thereby permitting the pawl **300** to rotate from the latched to the unlatched position, releasing the keeper. The deadstop lug **264** reaches the opposite end of slot **118**, preventing further rotation of the locking disk **250**. The cantilever **352** of roller switch **350b** is released, opening the roller switch **350b**. As force is released from the key, the lockplug **150** and lockplug driver **200** rotate under spring pressure to their central position wherein the wafers **158** engage the recess **64**, allowing removal of the key. The locking disk **250** will be spring-biased away from the open position, but will be secured in the open position by abutting pawl **300**.

The latch may be closed by merely slamming it shut. The keeper will push against the arm **306** of the pawl **300**, thereby rotating the pawl **300** into the latched position. Once

the pawl **300** is in the latched position, the keeper will be secured between the pawl nest **66** and pawl's arm **304**. The locking disk **250** is now free to rotate to the unlocked position of **FIG. 29** under spring pressure. Both roller switches **350** are depressed, signaling the latch's unlocked position.

To manually move the locking disk **250** from the unlocked position to the locked position, a key is first inserted into the key slot **152** of the lockplug **150**. The wafers **158** retract as the key is inserted, allowing the lockplug **150** to rotate. The key is rotated counterclockwise. For the first 45° of rotation, the lockplug driver **200** will rotate without engaging the driver post **254**. For the second 45° of rotation, the end of slot **214** will abut the driver post **254**, so that the lockplug driver **200** will rotate the locking disk **250**. Once the locked position is reached, the deadstop lug **264** reaches the end of slot **118**, preventing further rotation of the locking disk **250**. The cantilever **352** of roller switch **350a** is released, opening the roller switch **350a**. As force is released from the key, the lockplug **150** and lockplug driver **200** rotate under spring pressure to their central position wherein the wafers **158** engage the recess **64**, allowing removal of the key.

Operation of the latch using the motor **450** is accomplished through a combination of switches indicating the desired action of the user, and the signals from the roller switches **350a, 350b** indicating the present state of the latch **10**. These inputs can, for example, be directed to a programmable logic controller (PLC) which then controls the flow of electricity to the motor **450**. The following illustration assumes a dashboard mounted switch for moving the locking disk **250** between the unlocked and open positions only, and a remote key switch for moving the locking disk **250** between the locked and unlocked positions.

When the latch **10** is unlocked, both roller switches **350a, 350b** will be closed. When the PLC receives a signal from either switch instructing it to open the latch **10**, it will activate the motor **450** until the roller switch **350b** is open, signaling that the latch **10** is now open. When the PLC receives a signal from the key switch instructing it to lock the latch **10**, it will activate the motor **450**, supplying power to rotate the motor **450** in the opposite direction, until the roller switch **350a** is open, signaling that the latch **10** is locked.

When the latch **10** is locked, and the PLC receives a signal from the dashboard switch instructing it to open the latch **10**, the PLC will not open the latch **10**, because the roller switches **350a, 350b** will signal that the latch **10** is locked.

When the latch **10** is locked, and the PLC receives a signal from the key switch instructing it to unlock the latch **10**, the PLC will activate the motor **450** until the roller switch **350a** is closed. Similarly, when the latch **10** is locked, and the PLC receives a signal from the key switch instructing it to open the latch **10**, it will actuate the motor **450** until the roller switch **350b** is open.

Any time the latch **10** is manually operated, the motor **450** will simply rotate with the locking disk **250** as the force is transmitted through the gearbox **400**. However, throughout electronic operation of the latch **10**, the driver post **254** will move within the slot **214** without ever rotating the lockplug driver **200** or lockplug **150**.

It is to be understood that the invention is not limited to the preferred embodiments described herein, but encompasses all embodiments within the scope of the following claims.